REMARKS

Favorable reconsideration of the application in view of the amendments and remarks, is respectfully requested.

Claims 30, 31 and 33-39 are currently pending in the application. Claim 32 has been previously canceled. Changes to Claims 30 and 35 can be found in at least paragraphs [0047] and [0095] of the specification. No new matter has been added.

By way of summary, Claim 33 was objected to because of an informality. Claims 37 and 38 were rejected under 35 U.S.C. § 102(e) as being anticipated by Yamazaki et al. (U.S. 6,791,112; hereinafter Yamazaki). Claims 30, 31 and 33-36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamazaki in view of Ueno et al. (U.S. Pub. No. 2003/0008075; hereinafter Ueno).

Turning first to the rejection of Claims 37 and 38 under 35 U.S.C. § 102 as being anticipated by Yamazaki, Applicant notes that both inventions relate to technology of an electrode structure of a thin film transistor. Although the conductive layer of Yamazaki corresponds to Applicant's copper layer, in the present invention, the side, upper and lower surfaces are surrounded by first and second copper diffusion-preventing layers. In contrast, Yamazaki has a laminate film comprising a titanium film 1702, a film 1703 containing aluminum as a main component, and a titanium film 1704, where the lower surface is in direct contact with a gate insulation layer.

The electrode structure of the present invention is capable of supplying a minute electric current at low resistance compared to the wiring structure of Yamazaki, who uses an aluminum film or titanium film. Accordingly, the present invention has an advantage of being able to prevent copper from diffusing, which causes lowering of the resistance of the gate insulator layer, resulting in malfunction.

In column 4, lines 55-61 of Yamazaki it is disclosed that "the second conductive layers 114 and 117 may be made from low electrical resistivity in material such as aluminum (Al) or copper (Cu). For copper, however, it is necessary to use a structure in which copper is surrounded by silicon nitride in order to prevent diffusion of elemental copper." However, this description in Yamazaki does not teach or suggest Applicant's claim language because in Yamazaki, the first conductive layers 113 and 116 which make up the first gate electrode are formed of an element such as silicon, titanium or tantalum from the alloy containing one of these elements as a main constituent. In addition, since the copper layer of the present invention has a forward tapered cross section, it is possible to prevent the first and second copper diffusion-preventing layers surrounding the copper layer from getting thin at the edge portion. Thus, in the present invention, diffusion of copper is prevented more effectively than in Yamazaki.

From all of the above, Applicant believes that Claim 37 is not anticipated by Yamazaki. In addition Claim 38 which depends from Claim 37 is believed to be allowable because of its dependency from Claim 37.

Turning next to the rejection of Claims 30, 31, 33-36 under 35 U.S.C. § 103 as being unpatentable over Yamazaki in view of Ueno, Applicant notes that as set forth in paragraph [0151] of Yamazaki, the gate electrode shown in Figure 17c is structured as follows:

> a conductive silicon film 1701 is used as a first conductive layer;
> as a second conductive layer, copper film with copper as its main component 1707 and titanium film 1708 are laminated onto a laminate film and disposed over the conductive silicon film 1701;
> the first conductive layer and the second conductive layer constitute a first gate electrode; and
> a conductive silicon film 1705 survives as a second gate electrode, to cover the first gate electrode.

In addition, paragraph [0152] of Yamazaki describes that the conductive silicon film 1701 and 1705 contain nitrogen, preventing the diffusion of copper. The Official Action

(page 3) relies upon Figure 18B and column 20, lines 14-17 for the forward tapered cross section. It is assumed that the forward tapered configuration as indicated by the Official Action is the conductive layer 1804 shown in Figure 18B of Yamazaki. In this structure on top of the conductive layer 1804, a rectangular conductive layer 1802 and a conductive silicon film 1803 are formed. As shown in the conductive silicon film 1803 of Figure 18B, the edge portion is thinner than the other portion. In Yamazaki, the edge portion which contacts the interlayer insulation film does not constitute a forward tapered cross section as claimed, because in Yamazaki, neither the first nor the second conductive layers 1801 and 1902, respectively, are copper, and because the claims recite that the copper seed layer and the copper layer, which are covered by the first and second copper diffusion-preventing layers, have a forward tapered cross section.

The inventions of Yamazaki and Applicant also differ in the several aspects.

In Applicant's Claim 30, a low-resistance conductive portion has a two-layer structure in which a copper layer formed by an electroless plating method is provided on a copper seed layer, of which an undesired portion, which is a portion other than an area where the gate electrode is formed is removed. In contrast, Yamazaki has a structure in which "a titanium film 1708 is arranged above a copper film 1707."

The structure of a "copper layer formed on a copper seed layer" as recited in Claim 30 has a pattern of the copper seed layer corresponding to the form of a gate electrode. That is, by forming a copper layer on the copper seed layer by an electroless plating method, it is possible to selectively form the copper layer on the copper seed layer formed to have a pattern of a gate electrode. As a result, since it is possible to provide the copper material selectively on the wiring layer alone, the present invention is a structure which enables the utilization of a manufacturing method requiring fewer resources. In addition, being able to form a copper layer by the electroless plating method has the advantage of being able to form

the copper layer on a substrate having the size of meter angle. In contrast to the gate electrode of Yamazaki which has a titanium film 1708 over copper film 1707, as shown in Figure 17C, after forming a conductive silicon film 1701, the film 1707 having copper as its main component and in titanium film 1708 on the entire surface of the substrate, a photoresist pattern is supplied in the form of a gate electrode, and the titanium film 1708 is etched. Thereafter, the film 1707 having copper as its main component is also etched. Accordingly, Yamazaki requires a process which is contrary to the resource saving process of Applicant.

Further, since the film 1707, which has copper as its main component, is hard to process by a dry etching process, a wet etching process is adopted. Here, the etching weight of the titanium film 1708 is low when a normal wet etching liquid for copper is used. Further, the end surface of the film 1707 having copper as its main component is evenly formed as compared to the end surface of the titanium film 1708 due to the isotropy of the wet etching. For these reasons, it is hard to perform the processing which results in a vertical end surface as shown in Figure 17 of Yamazaki. With a dry etching process, titanium film 1708 is etched to have an ease-like projected shape, and there is a disadvantage that fine processing is hard to perform. Accordingly, there is also the problem that the entire covering of the conductive silicon film 1705 of Yamazaki is difficult to produce.

Figure 18 shows the embodiment of a film 1802 having aluminum as its main component and a conductive silicon film 1801 is provided as the underlayer, with conductive silicon film 1803 formed on the top. The figures of Figure 18 do not show a structure which is applied to a film having copper as its main component. From the cross sectional structure in the manufacturing process, film formation, patterning, and etching are performed separately so the film 1802 having aluminum as its main component, the conductive silicon film 1801 corresponding to the underlayer, and the conductive silicon film 1803 as the top layer.

The gate electrode as recited in Claim 30 is structured such that the copper layer formed on the copper seed layer is surrounded by a first copper diffusion-preventing layer and a second copper diffusion-preventing layer, wherein a cross section is of forward tapered shape. In contrast, the gate electrode of Yamazaki comprises a first gate electrode and a second gate electrode. The first gate electrode is comprised of a laminate film in which the titanium film 1708 is provided on top of film 1707. The second gate electrode is constituted by a conductive silicon film 1705 provided so as to cover the first gate electrode. Thus the structure of Claim 30 is different from the structure of Yamazaki.

Further, after the conductive silicon film 1705 is provided over the entire surface, it is necessary to perform the steps of photoresist patterning, and removal by an etching process. Thus, the characteristic feature of the invention of Yamazaki is the forming and control of the area containing low concentration impurities using the above steps.

Turning to Ueno, Ueno describes in paragraph [0005] that:

> "in case that a wiring layer 1 is made of Cu (copper), Cu constituting a wiring layer 1 diffuses into an insulating interlayer 2 so it may bring about bad insulation. Therefore, it is indispensable to interpose a diffusion-prevention layer between a wiring layer and the insulating interlayer and thereby prevent Cu from diffusing into the insulating interlayer.

Ueno further describes in paragraph [0029] that:

> In case that the wiring layer 1 is formed on this diffusion prevention layer 15 by electroplating, in particular, with copper, the diffusion-prevention layer 15 of TaN, TiN, or the like, as described above, is inferior in electrical conductivity. Accordingly, a Cu seed layer or the like as a conductive layer 17 is required."

The invention recited in Claim 30 relates to a thin film transistor in which the copper seed layer and the copper layer are surrounded by the first copper diffusion-preventing layer and the second diffusion-preventing layer, and the cross section has a forward tapered shape. In contrast, Ueno discloses technology of interposing the diffusion-preventing layer 15 between the wiring layer 11 and the insulating interlayer 13 and thereby preventing Cu from

diffusing into the insulating interlayer 13. The structure recited in present Claim 30 that a copper layer formed by an electroless plating method being provided on the copper seed layer of which an undesired portion, which is a portion other than an area where the gate electrode is formed, is removed is not taught or suggested by Ueno. Rather, Ueno describes that the reason why a copper seed layer is provided is to provide electrolytic plating for the copper layer.

Turning to the combination of Yamazaki and Ueno, the Office Action (pages 4 and 5) indicates that the invention recited in Claim 30 would have been obvious over the combined teachings of Yamazaki and Ueno. As described above, in the invention of Yamazaki, the silicon film layer 1705 formed to cover the first gate electrode is used as the second gate electrode. On the other hand, Ueno paragraph [0006] describes that "the diffusion preventing layer 15 of TaN, TiN, or the like, as described above, is inferior in electrical conductivity." Thus, it is assumed that the diffusion-preventing layer of Ueno cannot be used as a gate electrode. Accordingly, there is no reasonable basis for combining the disclosure of Ueno with Yamazaki, as advanced in the Official Action.

Turning to newly presented Claim 39, Applicant notes that this claim recites a nickel seed layer or seed layer made of a metal material of group VIIIa including a cobalt seed layer. Applicant believes that the cited prior art does not disclose or suggest a forward tapered cross section of this material as recited in Claim 39.

From all of the above, Applicant believes that Claims 30, 31 and 33-39 are now in condition for allowance. An early indication to that effect is respectfully requested.

Respectfully submitted,

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